9.0 INTRODUCTION TO MA CIRCUIT BREAKERS

Learning Objectives

Provide attendees with a basic understanding of the MA breaker and its purpose, operation and construction.

As a result of this lesson you will be able to understand:

1. The basic function of the MA circuit breaker
2. How the MA breakers are classed or grouped
3. How the breaker frame size method further identifies the breaker
4. The component attributes of the MA breaker:
    a. Chassis Mounting Arrangement
    b. Primary Circuit, Support Assemblies and Arc Chutes
    c. Electrical Devices including wiring
    d. Mechanical and Safety Interlocks
    e. Operator Assembly and Jackbar
    f. Puffer Assembly
5. Basic understanding of maintenance scheduling
6. Basic understanding of subcomponent replacement
7. Basic understanding of design upgrades for the MA breakers
8. Proper lubrication type for MA breakers
9. Basic understanding of routine maintenance using the Preventative Maintenance Manual for the MA Circuit Breaker

9.1 ALLIS CHALMERS

Allis Chalmers was the original name of the manufacturer of the MA style breaker they became Siemens Allis in 1978 and are now Siemens. In the 1960's they developed the MA, FB and FC series of circuit breakers. These units were originally offered with solenoid operated closing mechanisms, but eventually the design was changed to stored energy. The designs were designated:

- MA 75 - MA150 - MA250 - MA350

- FA350 - FB250 - FB500
- FC500 - FC750 - FC1000

9.2 WHAT IS AN MA CIRCUIT BREAKER?

The MA breaker was the first series in the design that eventually became FC. The MA breaker is classed by Voltage class, Ampere size and Interrupting capacity. The 5KV MA models include the MA-75, MA-150, MA-250 and the MA-350 with continuous currents of 1200A and 2000A.

9.3 HOW THE MA CIRCUIT BREAKERS ARE CLASSED

The MA breaker is made in several models. The best way to identify a MA Breaker is to read the nameplate. For example:

MA-250C1, 1200 Amp

MA- Air Magnetic
250C1-Interrupting Capacity (MVA)
1200 Amp- Maximum continuous amperage

9.3.1 Voltage Class: MA Circuit breakers are grouped by voltage class that is normally defined as **MEDIUM**.

9.3.2 Ampere Size: MA Circuit Breakers are grouped by “Frame Size” or “Ampere Size”. This is determined by the Load circuit the breaker controls under normal use. The MA breakers will most commonly be 1200 Amp and 2000 Amp.

9.3.3 Interrupting Capacity: MA Breakers are also grouped by its Maximum Interrupting capacity or MVA.

9.4 MAJOR COMPONENT ATTRIBUTES FOR THE MA BREAKER

The standard MA breaker is comprised of a main chassis containing an operating mechanism, primary current bus, arc chutes and insulated covers.

The MA circuit breaker is a “Draw Out” type breaker; this means that the breaker is RACKED IN to its cubicle by means of racking device. The primary current bus

is mounted on the chassis, the chassis contains the support assemblies to operate the breaker, the puffer assembly, operating mechanism assembly and various exteriors mount components t interface with the switchboard. Such as the coding plate, ground contact, primary and secondary disconnects.

9.4.1 Front cover, Insulator barriers, and Arc Chutes:

- The Front cover is a barrier between live parts of the breaker and personnel.
- Insulating barriers and cover- The Barriers isolate all the conductive parts of the breaker from each other and the breaker frame
- Arc chutes- Consists of Blow Out coils, Arc Runners and ceramic insulators. The Arc chute breaks up the Arc by magnetic and thermal effects when the breaker OPENS under load by dividing the arc into segments aided by a puff of air.

9.4.2 The primary phase assembly is the main current carrying part of the breaker. There are 3 sets of contacts mounted on individual insulated support assemblies, which mounts on the main metal chassis. The MA utilizes “BUTT” style contacts on the arcing contacts, meaning that meet flat together and a “JAW” style on the main contacts, meaning the contacts mate by sliding into each other (Figure 1). The contact assemblies consists of:

- Stationary Arcing Contacts- Designed to withstand the energy of the arc when the breaker opens under load. Typically made of a Silver Tungsten alloy or similar material. Arcing contacts always “MAKE” first and “BREAK” last.
- Stationary Main Contacts- Designed to carry the primary load current. Usually made of silver cadmium oxide alloy. Main contacts “make” last and “break” first.
- Moving Contact Assembly- Consisting of Main contacts, arcing contacts and Operating Link - The Moving Contact Assembly connects the “LINE” and “LOAD” bushings when the breaker is “CLOSED”. The Operating Link connects the Moving Contact to the jack bar and is also used to adjust contact wipe.

9.4.3 The electrical control devices for the MA Breakers mount in various locations under the contact structure on the chassis. They consist of the following:

- Auxiliary Switch- There is one switch with 8 contacts (4 N/C and 4 N/O on the switch) with an actuator linkage connected to the jackbar. The Auxiliary switch provides remote indication of breaker status and a permissive path to the Shunt Trip Coil, allowing the breaker to OPEN electrically. The switch consists of both “A” and “B” contacts. “A” contacts are OPEN when breaker is OPEN and CLOSED when the breaker is CLOSED. “B” contacts do the opposite of “A” contacts. The Auxiliary switch is mounted on the lower left side of the breaker chassis just behind the Secondary disconnect (Figure 2).

- Close Coil and Trip Coil- The close coil closes the breaker electrically, and the trip coil opens the breaker electrically. The close and trip coils are usually the same physically and electrically. The close coil is mounted on the Operator assembly on the lower left side between the auxiliary switch and the operator frame (Figure 3). The Trip coil is mounted in the lower front of the Operator assembly between the Opening springs.

- Reset Relay- the Reset Relay consists of 2 sets of contacts, 1 N/C and 1 N/O. The Reset Relay takes the place of the Latch Check switch and provides a permissive path for the close signal. Located inside the rear left breaker chassis behind the Auxiliary switch (Figure 4).

- 88 Switches- There are three 88 switches on the MA breaker, with1 N/C and 1 N/O contact on each switch.

    - The 88-1NC is in the motor circuit and is used to start the motor when the springs are DISCHARGED and stop the motor when the springs are fully CHARGED.
    - The 88- 1NO and provides a permissive path for the close circuit when the springs are fully CHARGED.
    - The 88-2NC is in the close control lockout circuit.
    - The 88-2NO energizes an indicator light when the springs are fully CHARGED.
    - The 88-3NC is in series with 88-1NO, holding the close control circuit open.
    - The 88-3NO introduces a resistor into the motor circuit to slow it down when the springs are CHARGED.

They are located on the rear left side of the Operator assembly on a mounting bracket (Figure 5).

- Resistor- slows the motor down after the springs are fully CHARGED. It is mounted on the left rear of the chassis.

- Charging Motor- Charges the Closing Spring via a series of gears and cams. The motor mounts on the right rear side of the Operator Assembly (Figure 6).

- Secondary Disconnect- The Secondary Disconnect consists of a single assembly with 16 spring-loaded fingers arranged in vertical a row. The fingers slide onto a ramped receptacle in the cubicle. The Secondary is the electrical interface to operate the breaker between the cubicle and the breaker when the breaker is RACKED IN or RACKED OUT. Also provides remote indication of breaker status. Mounted on left outside of the breaker chassis (Figure 7).

- Wiring- The control wiring connects all the electrical devices together and run from the front to the rear of the chassis.

9.4.4 Mechanical and Safety Interlocks

- Breaker Cell Coding Plate- Mounted on the left rear underside of the chassis, this coding plate or rejection bracket, keeps breakers of dissimilar ratings from being RACKED IN to the wrong cubicle.

- Floor Tripping and Spring Release Interlock- The Spring Discharge Interlock also actuates the Tripping lever when the breaker is hits a stop plate in the cubicle. A common linkage works to safely DISCHARGE the Closing spring when the breaker is RACKED IN or RACKED OUT by a foot lever on the front middle of the breaker chassis.

9.4.5 Operating Mechanism for the MA Breaker

The MA had a solenoid-operated mechanism but the nuclear plants that have MA breakers were all built after these breakers were built. There are several styles of stored energy operated mechanism designs for the MA breakers such as the SE-4 and 515-1.
The operating mechanism mounts directly under the primary contact assembly and is integral to the breaker chassis.

- The mechanism contains all the mechanical latches; toggle assemblies, cams, rollers, levers and linkages required to CHARGE, OPEN and CLOSE the breaker. It is connected to the Main contacts via 3 insulated linkages (Figure 8) and the Jack bar.

- The stored energy mechanism contains three independent systems, the Driving system, spring linkage and the four bar Toggle linkage. All these systems are independent components within the operating mechanism and only interface during their operating sequence.

- The Jack Bar (Operating Arm) is the interface between the operator mechanism and the primary contacts. It runs the length of the chassis left to right through levers and bearings. At the left end of the jack bar outside the chassis is the MOC switch actuator (Figure 9). This bracket actuates the MOC (Mechanically Operated Contact) switch located in the breaker cubicle providing remote indication that the breaker is OPEN or CLOSED.

- The opening springs are located in the middle front of the jack bar and help OPEN the breaker contacts when desired (Figure 10).

9.4.6 Puffer Assembly

The Puffer assembly consists of two reservoirs (Figure 10) located on the left and right side of the jackbar, connected on the front, to the chassis. Its purpose is to provide a puff of air through the insulating tubes and nozzles (Figure 1) to each contact assembly when the breaker is opened. It also acts a breaker open stop and dashpot for the contacts.

9.5 COMMON FAILURE MODES FOR THE MA BREAKER

The Allis Chalmers or Siemens Type circuit breakers are a low population breaker in the Nuclear Industry we believe only 2 plants use stored energy ACB breakers. There are very few specific reports on these breaker types due to the low population. The breakers would be prone to the same general failure modes that are common to most breakers that have generated reportable issues. Based on operating experience in non-nuclear applications there are several common replacement parts or operating issues with this breaker type.

9.5.1 NRC Information

The NRC site search for notices did not bring up any only information is listed. Most failures under Siemens were for vacuum breaker.

- Farley CCW Breaker Failures Dec 2007.
  Breaker was found to be out of adjustment and the breaker would trip free when attempting to close. The licensee's subsequent inspection of the failed DG04 breaker determined that it had an excessive trip latch gap of 0.063 inches, which was outside the manufacturer's recommended band of 0.015 - 0.047 inches.

9.5.2 Other breaker material issues.

- Just behind the Stationary Arcing contact on each phase is a ceramic flash block. Due to its proximity to the contact, the force of repeated operations usually cracks the block. Damage has been noted due to Arc chute misalignment and handling as well.
- The barriers are solid and with no alignment issues they hold up well. Over time chips, cracks and burns may warrant replacement on an as needed basis.
- The horizontal insulator plate that incorporates the Puffer tubes over the top of the Operator Assembly is very thin and doesn't hold up well to adverse conditions. Warping, cracks and holes are common failures.
- The Puffer Tubes themselves are partially surgical tubing and can dry out and become brittle and prone to cracking.
- Alignment issues can lead to more significant damage to barriers, frame and Primary disconnects. Alignment issues also can damage the MOC switch actuator or ground assembly.

9.6 MAINTENANCE SCHEDULING FOR THE MA BREAKER

The OEM Technical Manual for the MA dictates a specific scheduled maintenance cycle for the Operator Assembly. The Stored Energy Operator should be inspected at 2000 operations (1000 operations for MA-350). Items to be inspected:

- loose or broken parts
- check wiring
- check all switches
- test mechanical interlocks

After 10,000 operations (5,000 operations for MA-350):

- loose or broken parts
- check wiring
- check all switches
- test mechanical interlocks
- rebuild Operator Assembly

9.7 SUBCOMPONENT REPLACEMENT FOR THE MA BREAKER

During the PM cycle it is possible that some parts on the breaker will be found to be broken, bent, burnt, cracked or worn out. Replacement parts for most MA breakers are available (depending on vintage) and are supported by the OEM. Our experience is that older part identification is not very well supported by Siemens.

9.8 LUBRICATION TYPE FOR THE MA BREAKER

The recommended lubricants for the MA breaker are:

- During an overhaul, any non-current carrying part is lubricated with “Molycote 557”; Part # 15-171-270-001.It is a graphite-based lubricant that is dark gray or black in color. It is somewhat fluid grease that adheres well to its components. For the current carrying parts, Wipe clean and apply light coat of contact lubricant, Part # 15-171-370-002 is required.

- During a PM cycle, light machine oil is recommended for most mechanism parts and petroleum jelly is recommended for current carrying mating surfaces.

Care should be taken not to not mix and match different lubricants together.

The following table identifies the location and proper lubricant for each component listed.

General Circuit Breaker Lubrication Chart (PM Only)

Parts	Lubrication at Maintenance Period
Ground surfaces such as latches, rollers, etc.	Wipe clean and spray with “Molycote 557”, Part # 15-171-270-001
Nylon sleeve bearings *(Teflon-impregnated bronze)*	No Lubrication required.
Sleeve bearings and pivot pins and rotating parts.	Light Application of “Molycote Penelube”, Part # 15-171-270-002.
Sliding surfaces.	Light Application of “Molycote 557”
Air Puffer cylinders.	Wipe clean and apply # 3 transformer oil
Roller and needle bearings	No Lubrication required.
Dry pivot points.	No Lubrication required.
Primary and Secondary disconnects, arcing contact hinge and auxiliary switch contacts	Wipe clean and apply light coat of contact lubricant, Part # 15-171-370-002.
Moving Contact pivot joint and silver washer on contact arm	Wipe clean and apply light coat of contact lubricant, Part # 15-171-370-002.
Arcing contacts	No Lubrication required.
Charging Springs	No Lubrication required.
Arcing Contact pivot joint and silver washer on contact arm	Wipe clean and apply light coat of contact lubricant, Part # 15-171-370-002.

9.9 ROUTINE MAINTENANCE FOR THE MA BREAKER

It has already been established the importance of routine maintenance. It is important to have only properly trained and qualified personnel work on the MA breakers. During this training seminar, the objective is to utilize the PM Manual for the MA breaker to help in understanding the function of the breaker.

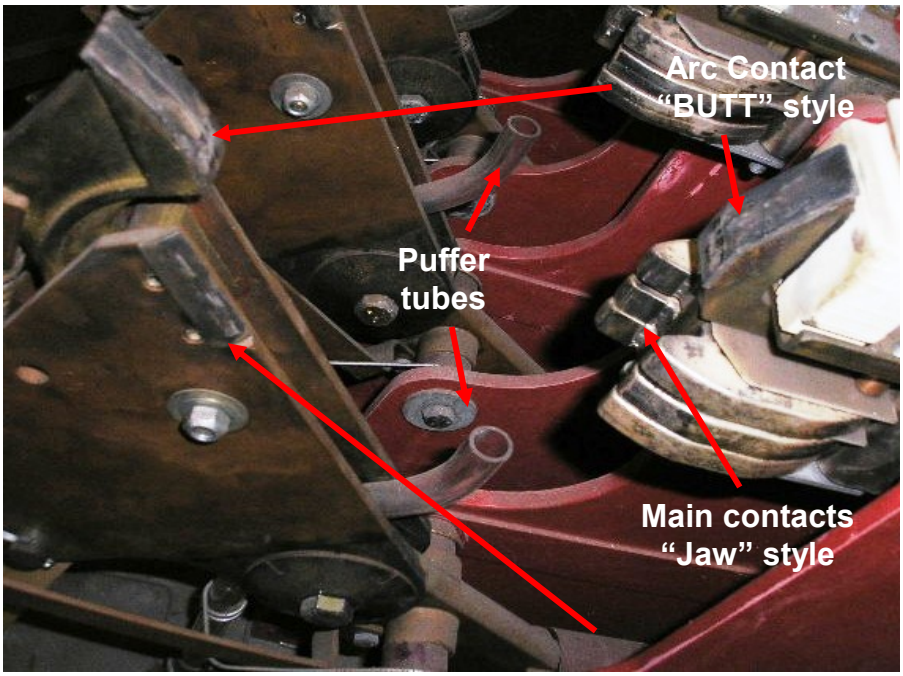

Figure 9-1 MA Contact and puffer tube

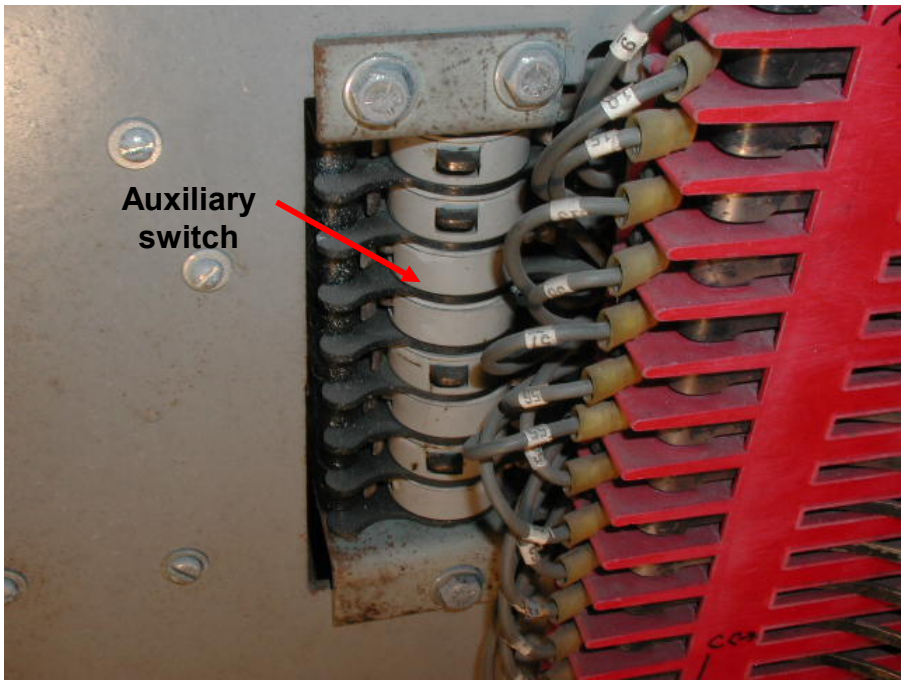

Figure 9-2 MA Auxiliary switch

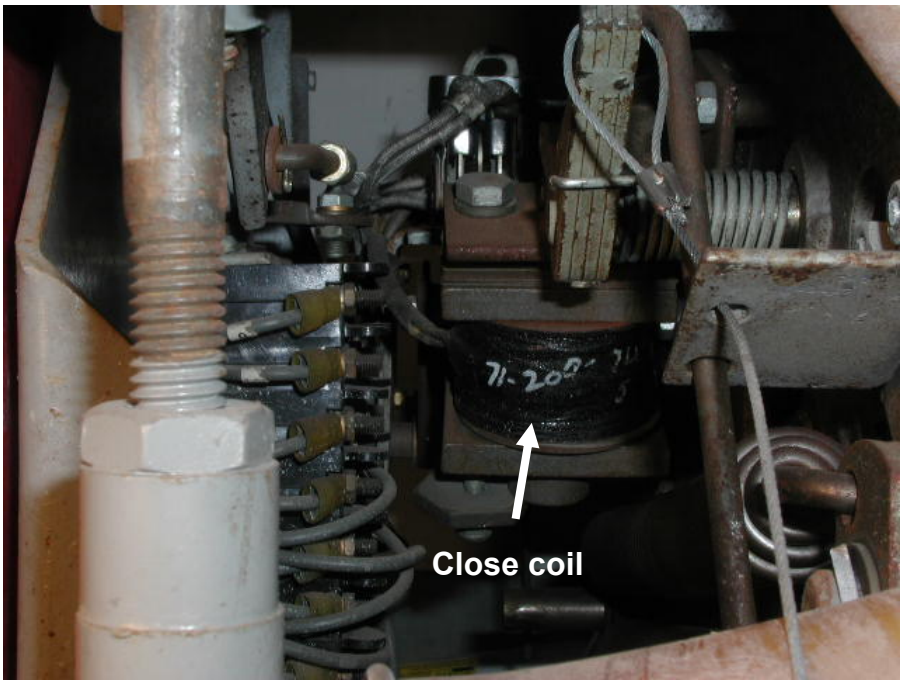

Figure 9-3 MA Close coil

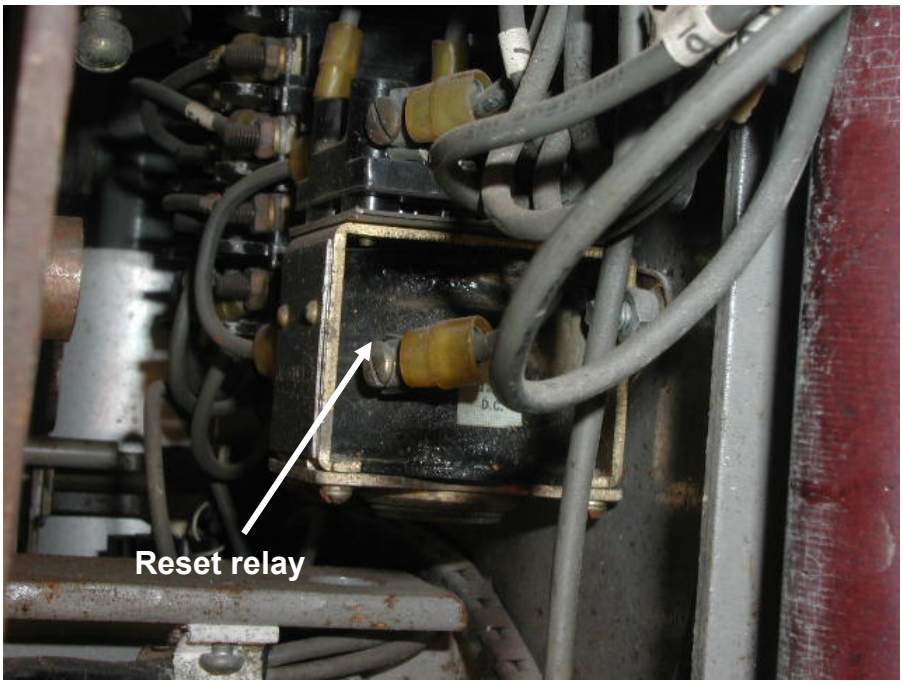

Figure 9-4 MA Reset relay

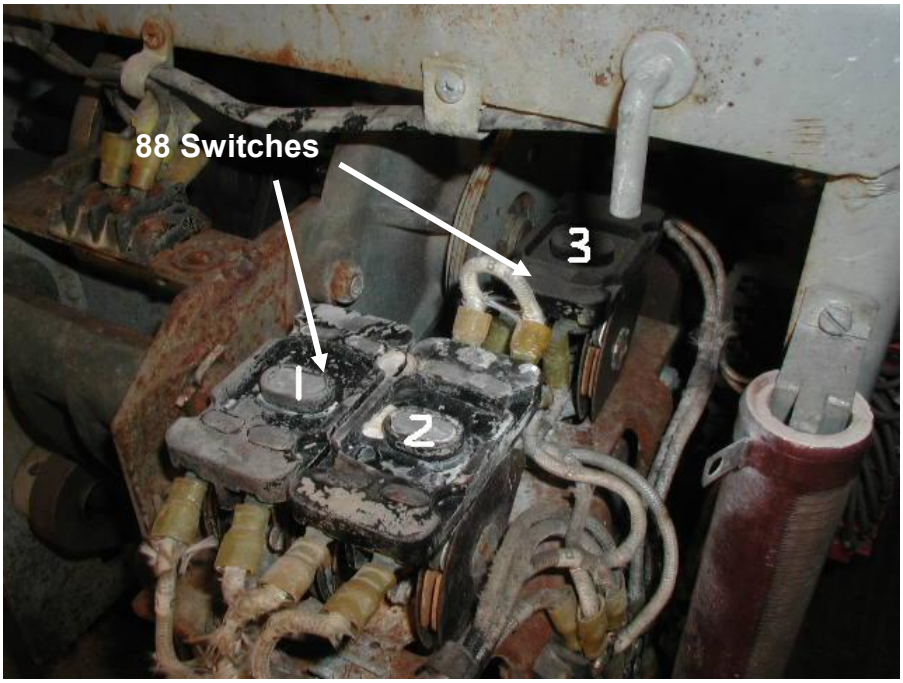

Figure 9-5 MA 88 switches

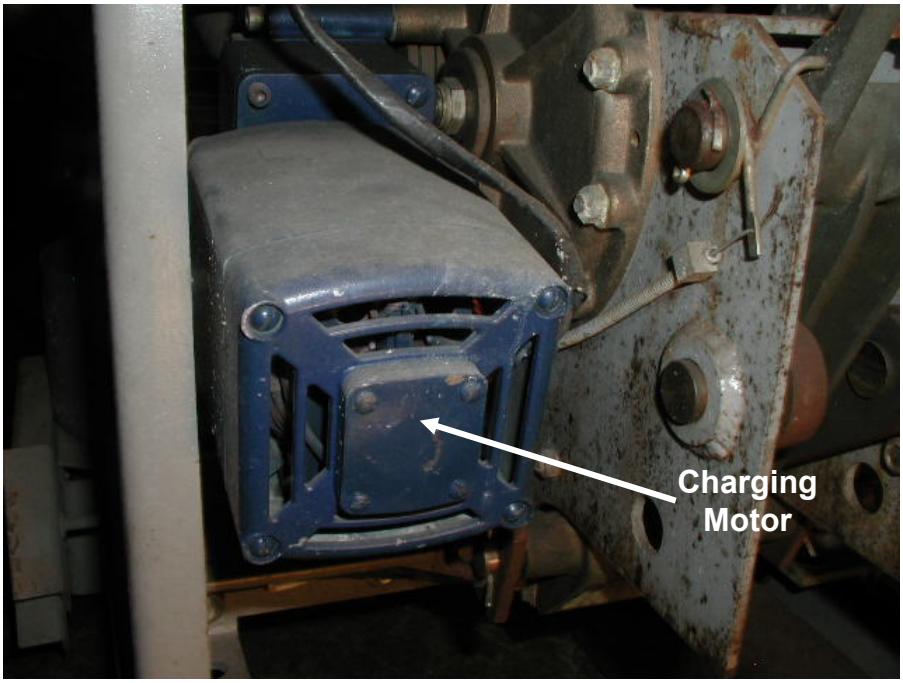

Figure 9-6 MA Charging motor

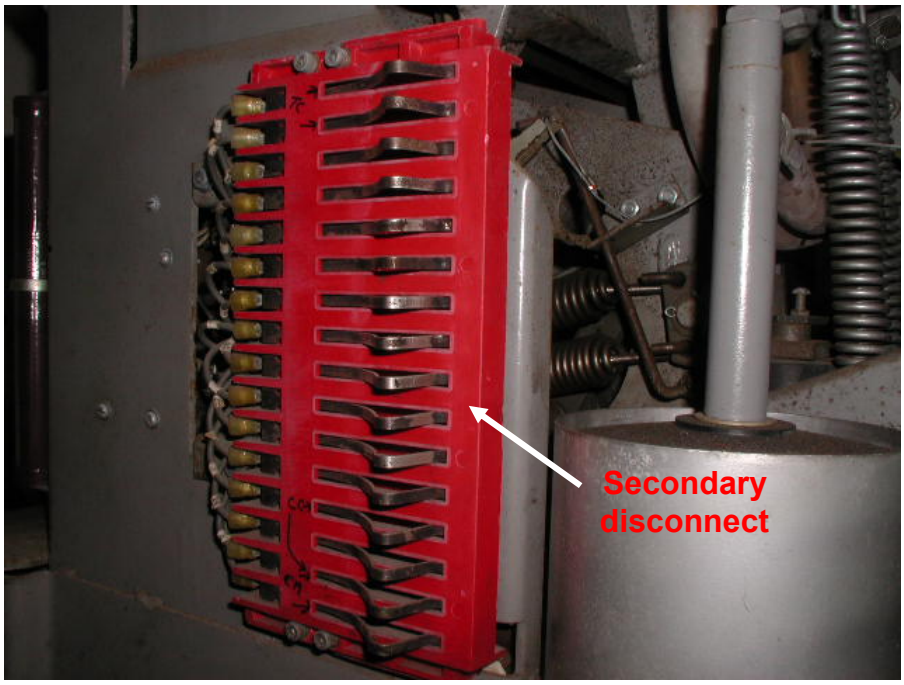

Figure 9-7 MA Secondary disconnect

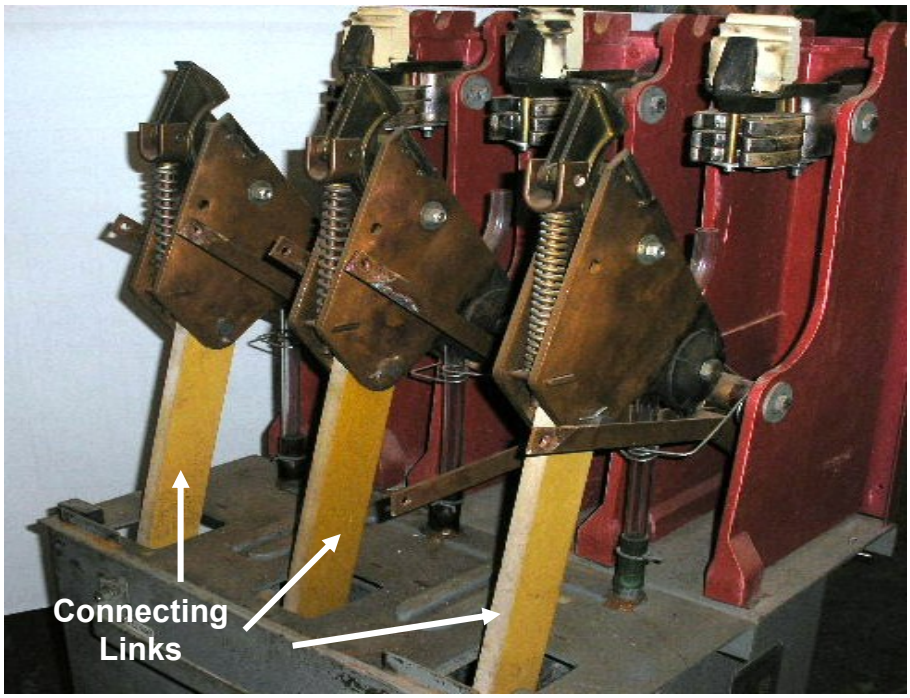

Figure 9-8 MA Connecting links

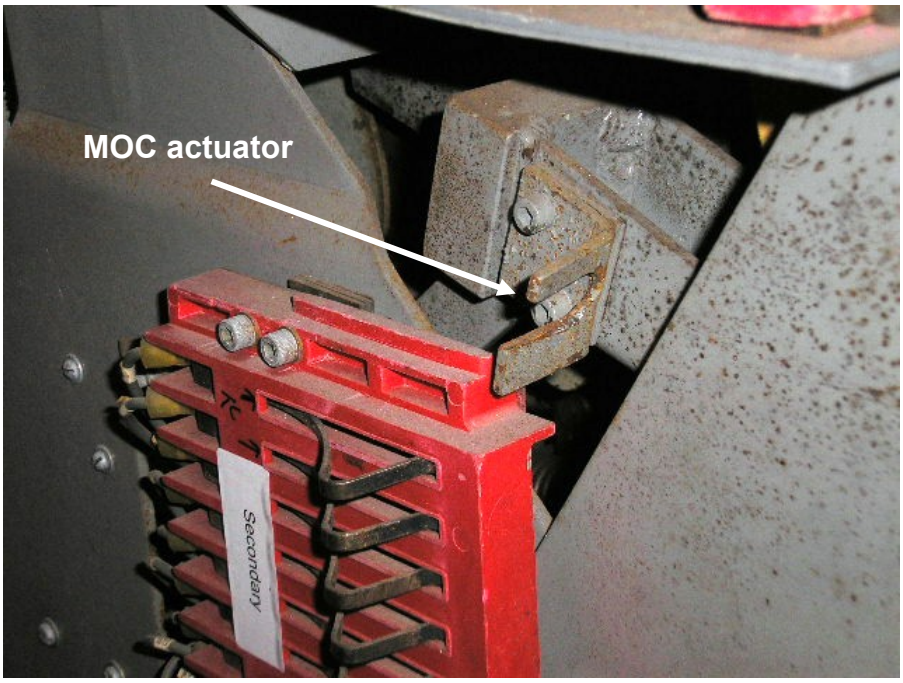

Figure 9-9 MA MOC switch actuator

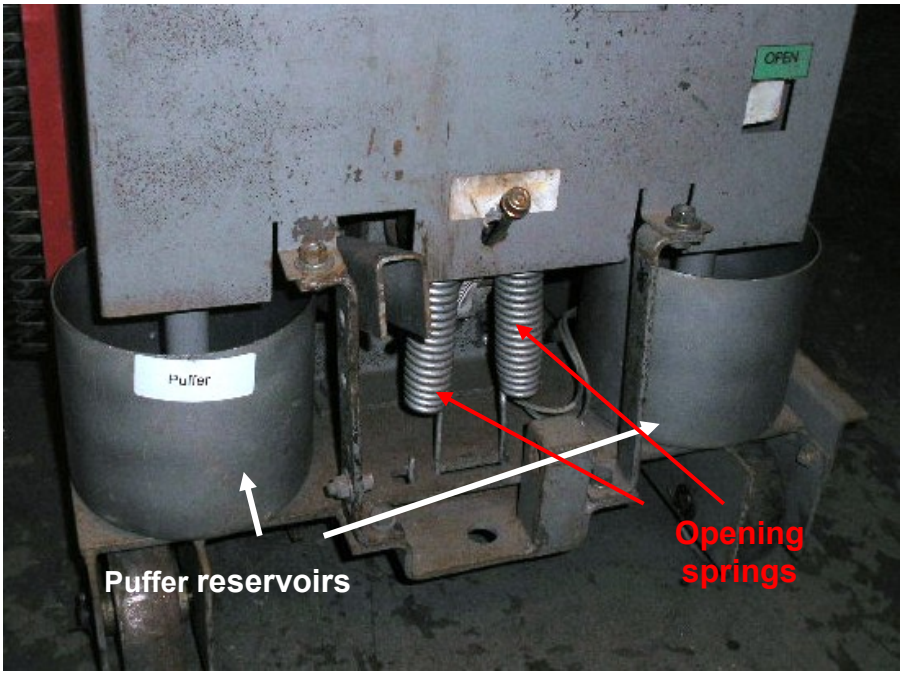

Figure 9-10 MA Puffer reservoirs and opening springs